Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

WATERSHED RESEARCH

in the Southern Great Plains

KANSAS

OKLAHOMA

TEXAS

WATERSHED RESEARCH

in the Southern Great Plains

In 1946, State and Federal agencies began work on a large-scale watershed development program in the Washita River basin of southwestern Oklahoma. Flood control, irrigation, recreational uses, and improvement of municipal water supplies were goals of the program.

The program is about two-thirds complete. Dams have been built, drainage systems installed, and channels improved. A variety of soil and water conservation techniques have been employed throughout the tributary system of the river.

Agricultural scientists now want to learn how these upstream modifications affect the main channel of the river. This work is the responsibility of hydrologists at the Southern Plains Watershed Research Center, Chickasha, Okla., and is part of a watershed research program conducted by the Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture.

Hydrologists are studying the Washita River watershed to learn, among other things, the effects of manmade conservation measures on streamflow, ground water level, bank erosion, and sediment movement along the main channel of the river. This information will be invaluable in the planning and development of other watershed programs throughout the country.

The Washita River watershed presents an excellent opportunity for hydrology research. The conservation program within the watershed has been carefully planned and developed, and construction data and other details of its history are readily available.

The Washita River rises in Roberts County, in the panhandle of Texas. It flows southeast across Oklahoma and empties into Lake Texoma in Johnson County, Okla. The watershed of the Washita is approximately 250 miles long and from 25 to 50 miles wide. Within

this watershed, the main channel of the river has a meandering length of 650 miles. Its drainage area is 7,960 square miles—470 square miles in Texas and 7,490 square miles in Oklahoma. Approximately 414 square miles of land along the tributaries and 175 square miles along the main channel are subject to flooding.

Economy in the area is predominantly agricultural, although oil and gas production are important activities in some parts of the area. About 38 percent of the watershed is in cultivated crops, 46 percent in open grassland, 11 percent in wooded grassland, 1 percent in woodland, and 4 percent in miscellaneous uses. Principal crops are small grain, cotton, grain sorghum, alfalfa, and corn.

The climate in the watershed is temperate and subhumid. Average annual temperature ranges from 58° to 64° F. Frostfree periods range from 197 to 233 days. Precipitation in the dry western part of the watershed ranges from 12 to 39 inches per year. In the south, the range is 19 to 58 inches per year. Three- to eight-week dry spells, usually accompanied by hot, dry winds, occur almost every growing season. Relief usually comes in the form of brief, violent rainstorms which produce heavy rainfall over small areas.

The watershed has been divided into seven conservation problem areas (see map, pp. 6-7). Three of these areas—Rolling Red Plains, Reddish Prairie, and Cross Timbers—comprise nearly 82 percent of the basin.

Facilities do not permit intensive study of the entire Washita River watershed. Consequently, a part of the river basin has been selected for detailed investigation (see map). In the part selected, establishment of conservation practices has not yet progressed as far as in the remainder of the watershed. Hydrologists will therefore be able to observe "before and after" trends as conservation practices are introduced in the area.

The study area contains a 78-mile segment of the main river channel. In the upper part of the segment, the banks are quite high, and the slope from one bank to the other is roughly U-shaped. Here, the banks are generally stable. In the lower part of the segment, the river bed flattens out and considerable bank erosion is taking place.

Alluvial deposits—soils that have been deposited by flood water—make up about 18 percent of the total study area. These deposits have built up through 3 distinct flooding cycles. In some places, the alluvial deposits are more than 100 feet deep. This soil is well developed agriculturally, but about half of it is subject to flooding in the tributaries and along the flood plain adjacent to the river.

Nine principal areas of study are being considered by the researchers at Chickasha: Precipitation, water absorption, grassland runoff, streamflow, subsurface water, sediment yield, stream channel stability, flooding tolerance of grasses, and flow regimen.

Precipitation: A network of 184 rain gages has been installed on the study area. Gages are located on a

3-mile by 3-mile grid—a density of one gage per 9 square miles of drainage area. The gages measure the amount of rain that falls and the time and duration of the rainfall. Rain gage charts are changed as soon as possible after each storm. Records from the charts are transferred to data cards by means of a mechanical chart reader. The data are then analyzed by computer.

Following is a summary of annual rainfall in the study area of the Washita River, 1962-64:

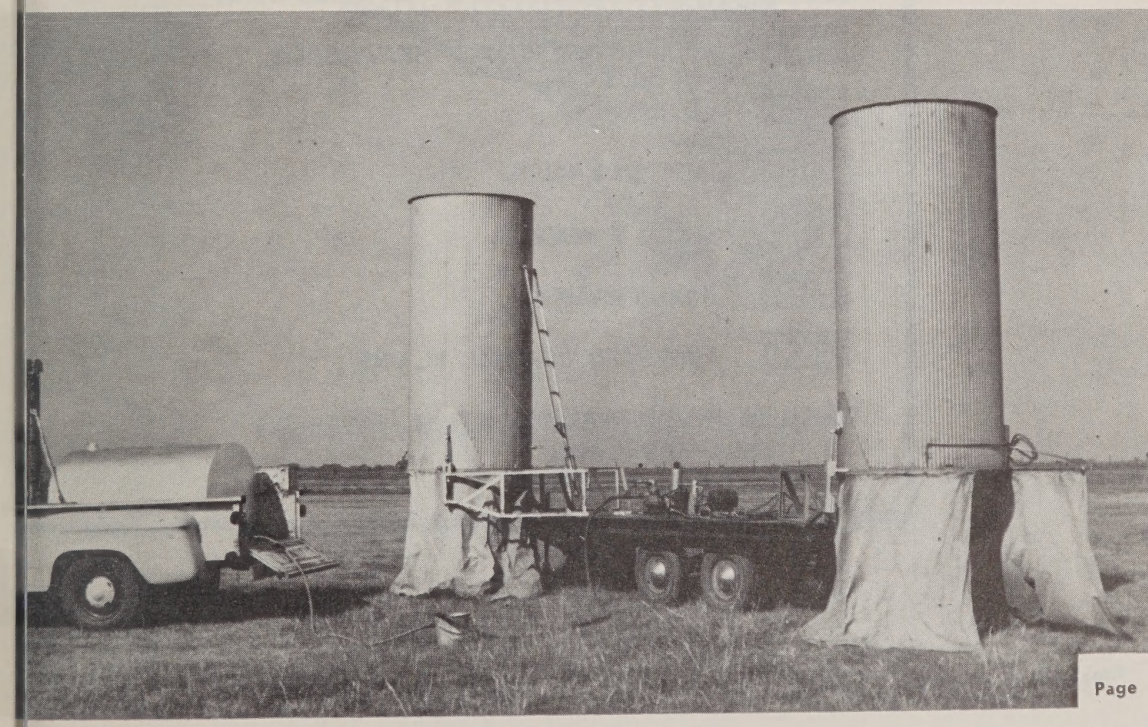
	1962	*1963*	*1964*
Average (inches)	28	19	29
Variation in distribution within the study area (inches)	22-37	15-28	23-37

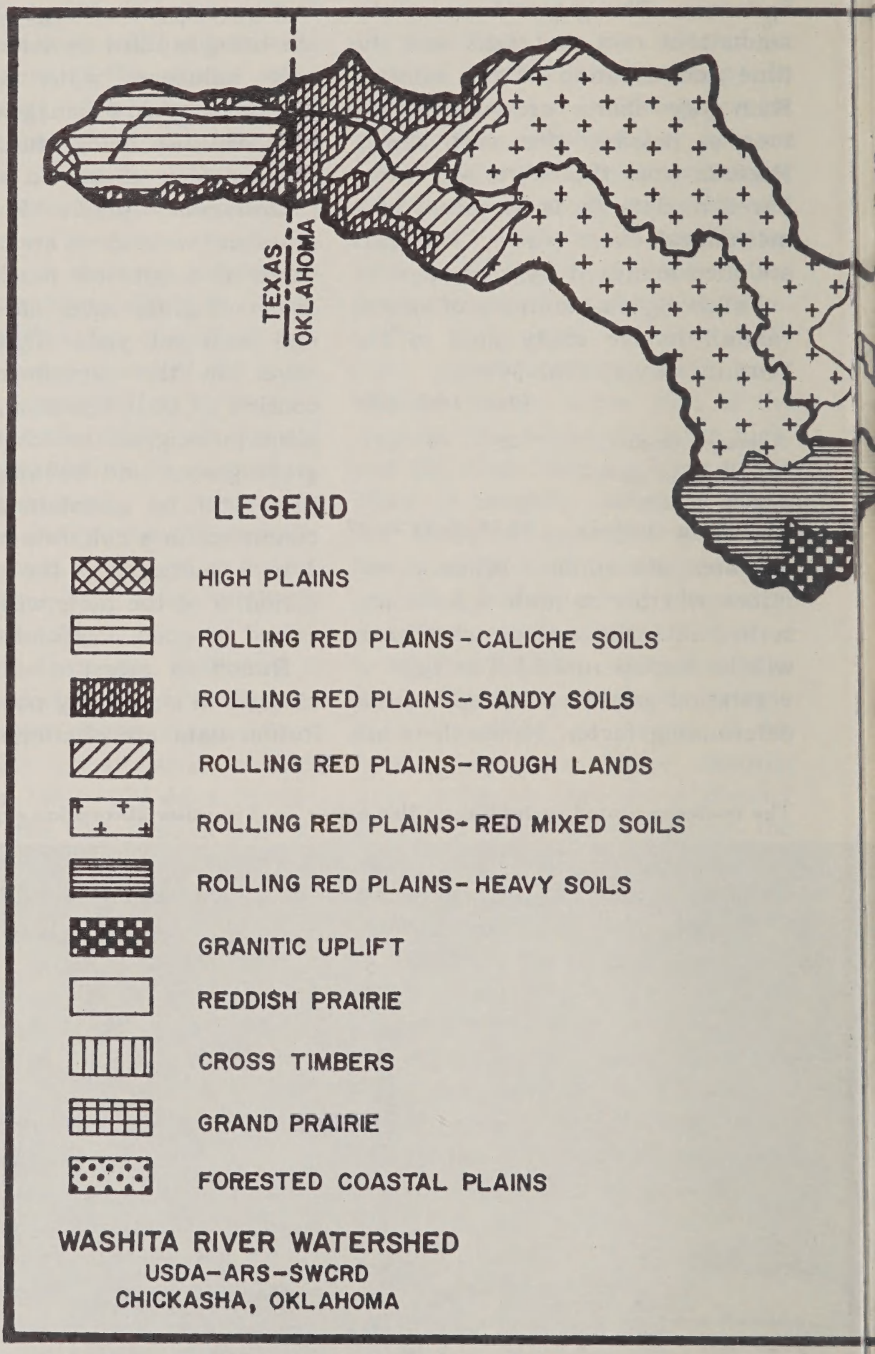
Water absorption: What determines whether rainfall will be absorbed into the soil or whether it will be lost in runoff? The type of vegetation grown on the soil is one determining factor. Researchers are using a trailer-mounted sprinkling device to produce simulated rainfall. Different types of vegetative cover are being studied to determine how each influences water absorption. Various cropland management practices are also being studied to determine their effects on absorption.

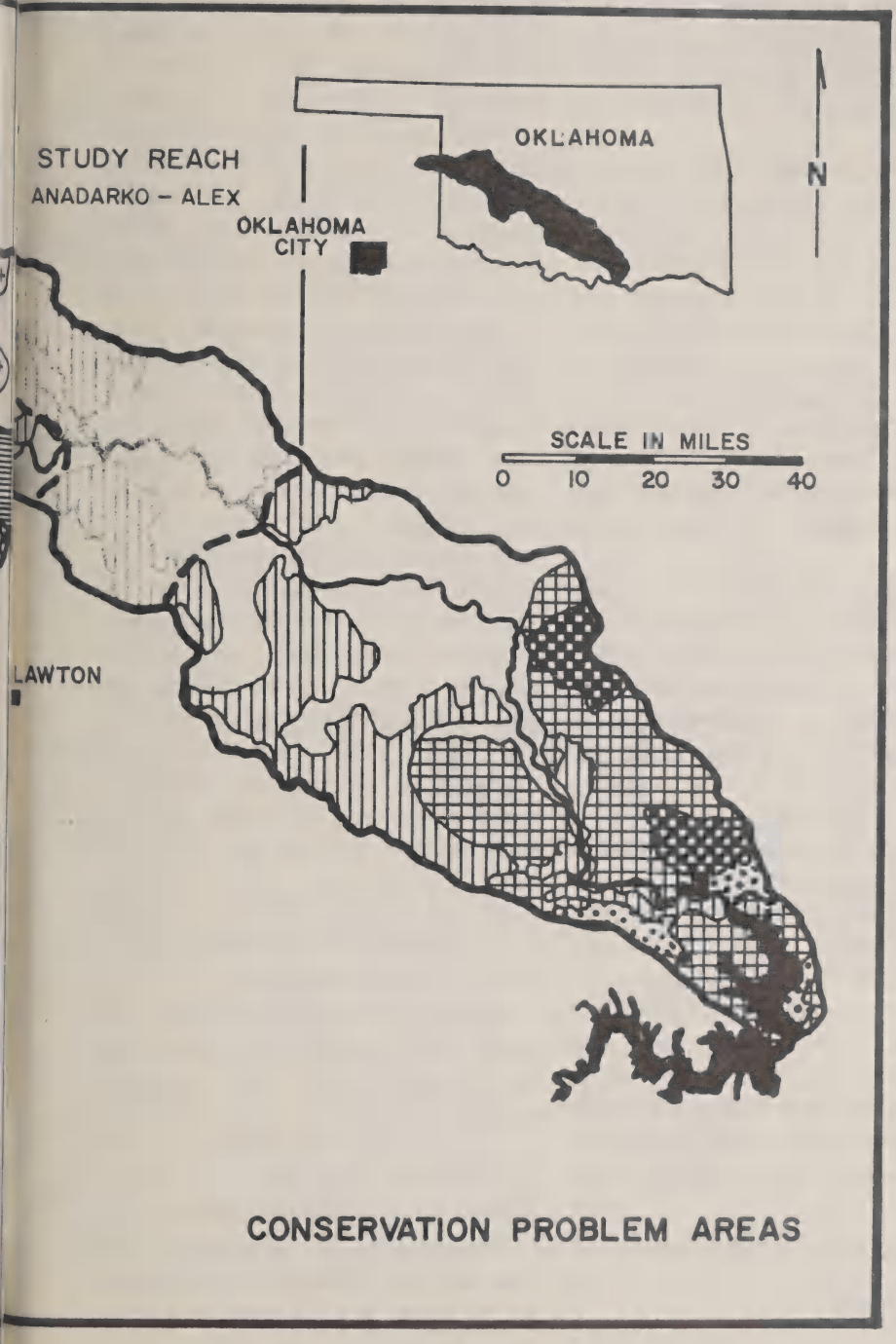
Grassland runoff: Four small grassland watersheds are being studied to find out how much the condition of grass cover affects runoff and sediment yield. Typical grass cover on the experimental plots consists of little bluestem, big bluestem, indiangrass, switchgrass, lovegrass, grama, and buffalograss. The plots will be maintained in poor condition for a calibration period of 3 to 5 years. After the calibration period, 2 of the plots will be maintained in good condition.

Runoff is measured by volume changes in a receiving pond; precipitation data are obtained from the

The trailer-mounted sprinkling infiltrometer used in water absorption experiments.




TEXAS
OKLAHOMA
LEGEND
HIGH PLAINS
ROLLING RED PLAINS - CALICHE SOILS
ROLLING RED PLAINS - SANDY SOILS
ROLLING RED PLAINS - ROUGH LANDS
ROLLING RED PLAINS - RED MIXED SOILS
ROLLING RED PLAINS - HEAVY SOILS
GRANITIC UPLIFT
REDDISH PRAIRIE
CROSS TIMBERS
GRAND PRAIRIE
FORESTED COASTAL PLAINS
WASHITA RIVER WATERSHED
USDA-ARS-SWCRD
CHICKASHA, OKLAHOMA



CONSERVATION PROBLEM AREAS

rain gage network; soil moisture gains and losses are measured with a neutron meter. Data from this study will help scientists predict the runoff and sediment yield from different types and conditions of grassland.

Cropland runoff: The relationships between cropland and runoff are being studied in experiments with cotton and alfalfa on alluvial soils. Studies of other crops and soil types are planned. Researchers will study the effects that changes in land use and management practices have on rainfall runoff relationships; a more complete understanding of the relationships between upstream and downstream hydrology may result.

Streamflow: Eighteen water stage recorders have been installed on the main channel and tributaries of the study area. A continuous record of stream stage, or water height, is obtained at each of these stations. The stream's rate of flow is determined by measuring water velocity. The stream discharge is recorded in cubic feet per second.

Such data are used to (1) identify factors affecting storm runoff and water yield; (2) determine the effects that conservation improvements have on storm runoff and water yield; and (3) establish methods of estimating flow characteristics in ungaged watersheds. Following is a summary of data collected from the study reach:

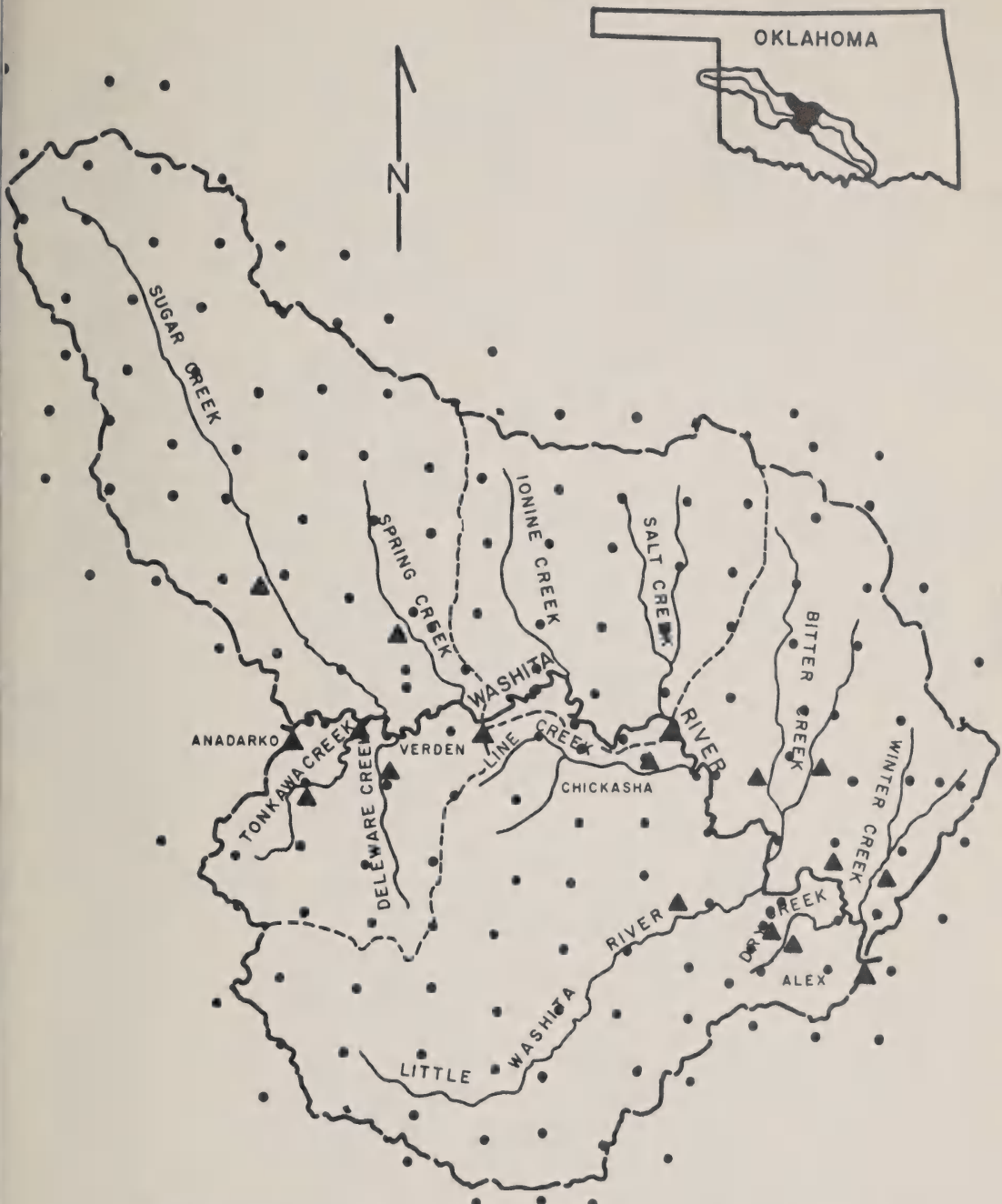
	1962	*1963*	*1964*
Average runoff (inches)	2	0.73	0.80
Variation among major tributaries (inches)	.....	0.3-1.3	0.3-2.9
Total runoff (acre-feet)	400,000	140,000	200,000

Subsurface water: Subsurface water—that is, soil moisture or water contained in underground reservoirs —is studied to determine its place in the hydrologic cycle and its response to the establishment of conservation practices. Wells have been drilled at various points in the study area, and cross sections and classifications of soil have been made. Pumping tests, water gradient records, and tracer chemicals are used to measure rates of subsurface flow. The interrelationships among water quality, geology, and the use and treatment of watershed lands are being studied. Improved quality and quantity of underground water supplies are goals of the study.

Sediment yields: Measurements of the amount of sediment carried by the river and its tributaries are made at several points. These samples are used as a basis for estimating the total sediment load discharged from the study area. Researchers are studying the effects that rainfall, runoff, land use, and other factors have on the size of the sediment load. Measurements of the sediment load will continue during and after the installation of watershed treatments in the study area.

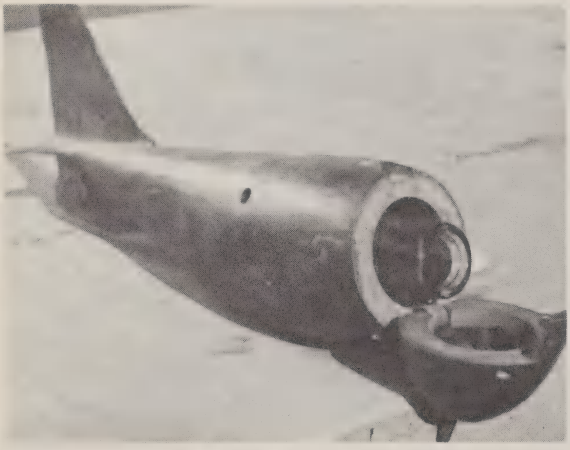
Sediment discharge from the study area totalled 862.3 tons per square mile in 1962; 156.1 tons per square mile in 1963; and 529.8 tons per square mile in 1964. Variation in sediment from year to year is related to precipitation and runoff.

Stream channel stability: The course of the Washita River channel in the study area is being recorded in aerial photographs and by conventional surveying techniques.



The Washita River study area. Triangles represent stream-gaging stations; dots represent rain gages.

Above, a researcher lowers one of the samplers into a Washita tributary.



A sediment sampler, used to obtain integrated water samples.

Changes in the course of the channel occur frequently, and researchers seek to distinguish between changes that are caused by natural processes and changes that are caused by large water-storage reservoirs and other watershed development structures.

Flooding tolerance of grasses: Floodwater detention reservoirs are principal features of the Washita River watershed program. These reservoirs are subject to periodic flooding; during non-flood periods their basins provide grazing for livestock, if suitable grasses exist. Researchers are testing grass varieties

to find out which varieties can withstand flooding.

Research thus far indicates that bermudagrass, buffalograss, vine mesquite, Kanlow switchgrass, and prairie cordgrass will survive as much as 20 days of flooding. Little bluestem, eastern grama, weeping lovegrass, and alkali sacaton will survive about 5 days of flooding.

Flow regimen: The rate and volume of flow in a river are governed by precipitation, size of drainage area, soil cover conditions, and many other factors. Data on these factors are being analyzed to determine the effect of watershed development programs on the river's flow.

The research in the Washita River depends on the collection of basic data. Many of the studies being established will be meaningful only as the length of record increases and as analyses and interpretations of the data are made. The research results will have a variety of applications. For example, data from the watershed's network of rain gages are being made available to the NSS Laboratory at Norman, Okla., and will be used to develop techniques for measuring rainfall by radar. But the chief purpose of the project is development of principles that can be applied as new water conservation projects are established in other parts of the country.

The flood tolerance of 24 plant species is being studied in this impoundment reservoir. Plants suitable for use in the floodwater detention reservoirs of the watershed are sought.

The research discussed in this publication is being conducted cooperatively by the Agricultural Research Service, the Oklahoma State University, and the University of Oklahoma Research Institute. Among the other Federal, State, and local agencies contributing data are the Oklahoma Water Resources Board, the Environmental Science Services Administration and the Soil Conservation Service.

Soil and Water Conservation Research Division

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